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SILVER BOW CREEK

QUALITY ASSURANCE PLAN

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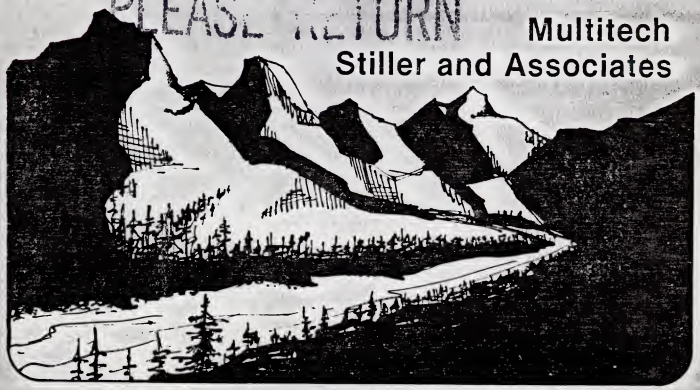

SILVER BOW CREEK

REMEDIAL INVESTIGATION
QUALITY ASSURANCE PLAN

By

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For

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LIST OF QA PLAN RECIPIENTS

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Project QA Officer _____

MDHES Project Manager _____

MDHES QA Officer _____

Laboratory Manager _____

Laboratory Personnel _____

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Field Personnel _____

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1.0 INTRODUCTION

The purpose of the Remedial Investigation of the Silver Bow Creek "Superfund" site is to determine the extent and severity of contamination of Silver Bow Creek and the Upper Clark Fork River and to compare and evaluate potential remedial actions. To meet these objectives, the Remedial Investigation will, in part, require the collection and analysis of materials for selected constituents. This Quality Assurance (QA) Plan has been prepared to ensure that field and laboratory investigations provide data of a nature and quality consistent with the objectives of the Remedial Investigation, and provides in specific terms the policies, organization, objectives, functional activities, and specific quality assurance (QA) and quality control (QC) objectives and activities necessary to meet the goals of the project.

Although frequently used interchangeably, the terms quality assurance and quality control refer to two different concepts. Quality assurance is the "system for ensuring that all information, data, and resulting decisions compiled under a specific task are technically sound, statistically valid, and properly documented" (USEPA 1982). Quality control is the "mechanism through which quality assurance achieves it's goals," (USEPA 1982a).

The format of this QA plan, which also incorporates QC activities, has been designed to be consistent with requirements of the U.S. Environmental Protection Agency, (USEPA 1980).

1.1 PROJECT DESCRIPTION

The Remedial Investigation of Silver Bow Creek is being directed by the Solid Waste Management Bureau of the Montana Department of Health and Environmental Sciences (SWMB/MDHES) under a Cooperative Agreement with the Environmental Protection Agency (EPA). The actual implementation of the Remedial Investigation will be performed by a contractor to SWMB/MDHES. Prior to implementation of the Remedial Investigation SWMB/MDHES contracted for Investigation Support from MultiTech and Stiller and Associates. The Quality Assurance Plan is an element of the Investigation Support package.

The place this Investigation Support takes in the overall process of identifying remedial actions for the Silver Bow Creek site is shown in Figure 1-1.

The investigation support activities are scheduled for completion in July, 1984 with the Remedial Investigation field work commencing as soon as possible thereafter. The remedial investigation field activities are scheduled to end the Summer of 1985 with the feasibility study completed by the Fall of 1985. Engineering planning and actual implementation of the conceptual design will follow completion of the feasibility study.

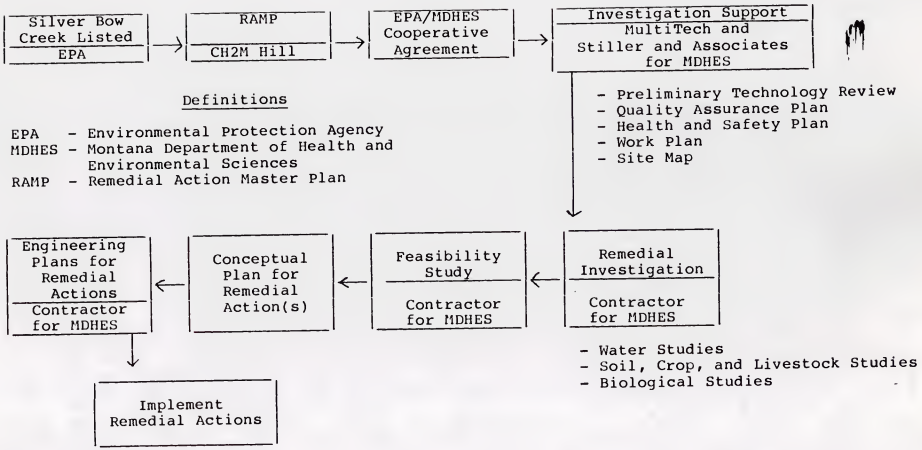
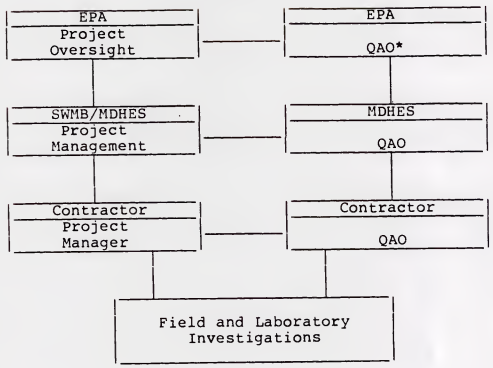


FIGURE 1-1.--SILVER BOW CREEK REMEDIAL INVESTIGATION PROCESS

1.2 PROJECT ORGANIZATION

Figure 1-2 illustrates the proposed project organization and the proposed QA chain of decision. This organization has been designed in response to MDHES' responsibilities to EPA under their Cooperative Agreement for the Silver Bow Creek Site. The Contractors Quality Assurance Officer (QAO) will have the responsibility for ensuring the collection of valid measurement data, the routine assessment of measurement systems for precision and accuracy, and the QA reporting described in this plan



EPA QAO _____

MDHES QAO _____

Contractor QAO _____

* QAO = Quality Assurance Officer

FIGURE 1-2.--PROJECT ORGANIZATION

2.0 QUALITY ASSURANCE (QA) OBJECTIVES FOR MEASUREMENT DATA

2.1 TERMINOLOGY

The QA objectives for acquisition and analysis of those aquatic and terrestrial sample matrices pertinent to this investigation are defined in terms of the six parameters discussed below.

2.1.1 Accuracy

Accuracy is defined as the degree of agreement of a measurement with the "true" or accepted value for the measurement. For the purpose of this study the primary assessment of accuracy will be the Known Sample Agreemnt percent, KSA(%), and Spiked Sample Recovery percent, SSR(%), defined as follows:

$$KSA(\%) = \frac{X - T}{T} \times 100\% \qquad (2\text{-}1)$$

where: X = measured value

T = "true" or accepted value

$$SSR(\%) = \frac{\text{(Spiked Sample Result)} - \text{(Sample Result)}}{\text{(Spike Added)}} \times 100\% \qquad (2\text{-}2)$$

2.1.2 Precision

Precision is defined as the measure of mutual agreement among indi-

vidual measurements of the same property, usually under prescribed similar conditions.

For the purpose of this study, the Duplicate Sample Agreement percent, DSA(%), defined by the following equation, will be used as the measure of precision:

$$DSA(\%) = \frac{d_1}{(d_1 + d_2)/2} \times 100\% \qquad (2\text{-}3)$$

where: d_1= first sample result

d_2= second sample result

2.1.3 Completeness

Completeness is defined as a measure of the amount of valid data obtained from a measurement system, compared to the amount that was expected to be obtained under correct "normal" conditions, and is expressed algebraically by

$$\text{Completeness } (\%) = \frac{NV}{NT} \times 100\% \qquad (2\text{-}4)$$

where: NV = the number of valid measurements

NT = the expected number of measurements

2.1.4 Representativeness

This is a qualitative term which expresses the degree to which data accurately and precisely represent a characteristic of a population,

variations at a sampling site location, a process condition, or an environmental condition.

"Representative" data has two important properties. First, it is an accurate indicator of a measured condition of the system sampled at a particular time and place. Secondly, there is complete certainty that the measurement can be ascribed to the particular sample, rather than some other sample other site. The second property is accomplished by maintenance of a rigorous chain-of-custody system and proper data management.

2.1.5 Comparability

This term is a qualitative characteristic which expresses the confidence with which one data set can be compared to another,(USEPA 1980). Comparability must be assured in terms of sampling plans, analytical methods, quality control, data reporting, etc.

2.1.6 Method Detection Limit

This term is defined as the concentration of analyte which would yield an analyte signal three times greater than the standard deviation of ten replicate measurements of a blank signal.

TABLE 2-1. EQA OBJECTIVES FOR ACCURACY, PRECISION, METHOD DETECTION LIMIT, AND COMPLETENESS FOR AQUEOUS SAMPLES

Measurement/ Method	Reference[a]	DSA(%)[b] & KSA(%)[b]	SSR(%)[c]	MDL (mg/l)	Complete-ness
pH/Electrometric	150.1	<± 0.1 pH	N.A.	N.A.	90%
Specific Conductance/ Conductimetric	120.1	85-115	N.A.	1 µmho/cm	90%
Temperature/ Thermometric	170.1	<±1°C	N.A.	N.A.	90%
Filterable Residue/ Gravimetric	160.1	90-110	N.A.	10.	90%
Non-Filterable Residue/Gravimetric	160.2	90-110	N.A.	4.	90%
Acidity/Titrimetric	305.1	90-110	N.A.	20.	90%
Alkalinity/Titrimetric, Colorimetric	310.1 or 310.2	90-110	N.A.	20.	90%
Hardness/Colorimetric, Titrimetric	130.1 or 130.2	90-110	75-125	20.	90%
Sodium/Atomic Absorption Spectroscopy (AAS)	273.1	90-110	75-125	0.010	90%
Potassium/AAS	258.1	80-120	75-125	0.020	90%
Calcium/AAS	215.1	90-110	75-125	0.100	90%
Magnesium/AAS	242.1	90-110	75-125	0.010	90%
Chloride/Colorimetric, Titrimetric	325.1, 325.2, or 325.3	90-110	75-125	1.0	90%
Fluoride/ Potentiometric	340.2	90-110	75-125	0.30	90%
Nitrate/Colorimetric	352.1	90-110	75-125	2.0	90%
Sulfate/Turbidimetric	375.4	90-110	75-125	2.0	90%
Sulfide/Titrimetric, Colorimetric	376.1 or 376.2	90-110	75-125	0.05	90%

TABLE 2-1. QA OBJECTIVES FOR ACCURACY, PRECISION, METHOD DETECTION LIMIT, AND COMPLETENESS FOR AQUEOUS SAMPLES (CONTINUED)

Measurement/ Method	Reference[a]	DSA(%)[b] & KSA(%)[b]	SSR(%)[c]	MDL (mg/l)	Complete-ness
Orthophosphate, Total/ Colorimetric	365.1, 365.2 365.3 or 365.4	90-110	75-125	0.02	90%
Ammonia Nitrogen/ Potentiometric	350.3	90-110	75-125	0.10	90%
Cyanide, Total/ Titrimetric	335.2	90-110	75-125	0.010	90%
Kjeldahl Nitrogen, Total/Colorimetric, Titrimetric	351.1, 351.2, 351.3, or 351.4	70-130	60-140	2.0	90%
Aluminum/AAS	202.1 or 202.2	85-115	75-125	0.2	90%
Antimony/AAS	204.1 or 204.2	85-115	75-125	0.02	90%
Arsenic/AAS-Hydride	206.2 or 206.3	85-115	75-125	0.010	90%
Barium/AAS	208.1 or 208.2	85-115	75-125	0.100	90%
Beryllium/AAS	210.1 or 210.2	90-110	75-125	0.005	90%
Boron/AAS	212.3	85-115	75-125	0.100	90%
Cadmium/AAS	213.1 or 213.2	90-110	75-125	0.001	90%
Chromium/AAS	218.1 or 218.2	85-115	75-125	0.010	90%
Cobalt/AAS	219.1 or 219.2	90-110	75-125	0.050	90%
Copper/AAS	220.1 or 220.2	85-115	75-125	0.050	90%

TABLE 2-1.--QA OBJECTIVES FOR ACCURACY, PRECISION, METHOD DETECTION LIMIT, AND COMPLETENESS FOR AQUEOUS SAMPLES (CONTINUED)

Measurement/ Method	Reference[a]	DSA(%)[b] & KSA(%)[b]	SSR(%)[c]	MDL (mg/l)	Complete-ness
Iron/AAS	236.1 or 236.2	85-115	75-125	0.050	90%
Lead/AAS	239.1 or 239.2	85-115	75-125	0.005	90%
Manganese/AAS	243.1 or 243.2	85-115	75-125	0.015	90%
Mercury/AAS-Cold Vapor	245.1 or 245.2	85-115	75-125	0.0002 (0.2µg/l)	90%
Molybdenum/AAS	246.1 or 246.2	90-110	75-125	0.200	90%
Nickel/AAS	249.1 or 249.2	90-110	75-125	0.040	90%
Phosphorous, Total	365.2 or 365.3	90-110	75-125	0.020	90%
Selenium/AAS	270.2 or 270.3	85-115	75-125	0.002	90%
Silver/AAS	272.1 or 272.2	90-110	75-125	0.010	90%
Thallium/AAS	279.1 or 279.2	85-115	75-125	0.010	90%
Tin/AAS	282.1 or 282.2	90-110	75-125	0.020	90%
Vanadium/AAS	286.1 or 286.2	90-110	75-125	0.200	90%
Zinc/AAS	289.1 or 289.2	85-115	75-125	0.010	90%

TABLE 2-1.--QA OBJECTIVES FOR ACCURACY, PRECISION, METHOD DETECTION LIMIT, AND COMPLETENESS FOR AQUEOUS SAMPLES (CONTINUED)

Measurement/ Method	Reference[a]	DSA(%)[b] & KSA(%)[b]	SSR(%)[c]	MDL (mg/l)	Completeness
Pentachlorophenol/ Gas Chromatography (GC)	604	90-110	75-125	0.014	90%
Polychlorinated Biphenyls (PCB)	-	-	-	-	-
PCB-1016/GC	608	90-110	75-125	0.050	90%
PCB-1221/GC	608	90-110	75-125	0.050	90%
PCB-1232/GC	608	90-110	75-125	0.050	90%
PCB-1242/GC	608	90-110	75-125	0.050	90%
PCB-1248/GC	608	90-110	75-125	0.050	90%
PCB-1254/GC	608	90-110	75-125	0.050	90%
PCB-1260/GC	608	90-110	75-125	0.050	90%

Notes: [a] Reference numbers for parameters pH through Zinc refer to Method numbers in Methods for Chemical Analysis of Water and Wastes, (USEPA 1983a). Other reference numbers refer to EPA Method Numbers given in Methods for Organic Chemical Analysis of Municipal and Industrial Waste Water, (USEPA 1982a).

[b] or ±2/3 the required MDL, whichever is larger.

[c] spike at 100% to 200% of the measured concentration or 3 to 4.5 times the required MDL, whichever is greater.

TABLE 2-2 QA OBJECTIVES FOR ACCURACY, PRECISION, METHOD DETECTION LIMIT, AND COMPLETENESS FOR SUSPECTED LIQUID HAZARDOUS WASTES

Measurement/ Method	Reference[a]	DSA(%)[b] & KSA(%)[b]	SSR(%)[c]	MDL (mg/l)	Completeness
Arsenic/AAS-Hydride	7060 or 7061	90-110	75-125	1.0	95%
Barium/AAS	7080 or 7081	90-110	75-125	20.0	95%
Cadmium/AAS	7130 or 7131	90-110	75-125	0.2	95%
Chromium/AAS	7190, 7191, 7195, 7196, or 7197	90-110	75-125	1.0	95%
Lead/AAS	7420 or 7421	90-110	75-125	1.0	95%
Mercury/AAS-Cold Vapor	7470	90-110	75-125	0.04	95%
enium/AAS	7740 or 7741	90-110	75-125	0.20	95%
Silver/AAS	7760 or 7761	90-110	75-125	1.0	95%

Note: [a] Reference numbers refer to method numbers in Test Methods for Evaluating Solid Wastes, (USEPA 1982b).

[b] or ±2/3 the required MDL, whichever is larger.

[c] spike at 100% to 200% of the measured concentration or 3 to 4.5 times the required MDL, whichever spike level is greater.

2.2 QA OBJECTIVES FOR AQUEOUS SOLUTIONS

QA objectives for aqueous solutions, for appropriate parameters (i.e., accuracy, precision, method detection limit (MDL), and completeness) are shown in Tables 2-1 and 2-2.

2.2.1 Criteria for Derivation of Method Detection Limit

The MDL values shown in the tables were selected in order to classify aqueous samples as falling into one of three categories: 1) potable; 2) not potable but not a hazardous waste; or 3) a hazardous waste. This was done using the following criteria.

For many of the parameters, the USEPA specifies MDLs required of USEPA contract laboratories. When available, these values were specified in Table 2-1. The USEPA has set these MDLs at 20% of the Interim Primary and Secondary Drinking Water Regulations maximum permissible values, (Federal Register, March 12, 1982).

For these parameters not possessing specific contract laboratory MDLs, but for which EPA drinking water standards exist, the required MDLs were set at 20% of the Interim Primary and Secondary Drinking Water Regulations maximum permissible values.

For parameters not controlled by contract laboratory specifications or by regulation, the required MDLs were set to levels found to be reasonably achievable by EPA laboratory surveys (USEPA 1983a; USEPA 1982a).

2.2.2 Application of the MDL Criteria to Screening for "Hazardous Waste" Samples

The MDLs of Table 2-1 are useful for classifying water samples as potable or not potable. However, classification of materials as hazardous wastes requires different analytical procedures, with a different set of maximum permissible concentrations. The MDLs of Table 2-2 were set to values which are 20% of the maximum permissible values for inorganic constituents for EP toxicity extracts not classified as hazardous wastes, (USEPA 1982b). The less expensive "potable water" analytical methods should be utilized initially for those samples which may be "hazardous wastes." If the resulting concentrations (e.g., for As) exceed 50% of the respective hazardous waste criteria (EP toxicity) then the samples should be reanalyzed using the appropriate hazardous waste procedures.

2.2.3 Criteria for Accuracy, Precision, and Completeness Levels

The QA objectives for accuracy, precision, and completeness shown in Tables 2-1 and 2-2 were set to values consistent with the anticipated end use of the data and were judged to be reasonably achievable based on surveys conducted by the USEPA (1983b).

2.2.4 Requirements for Representativeness and Comparability

In addition to the required QA objectives for accuracy, precision, method detection limit, and completeness, two further specifications

must be satisfied. Firstly, all measurements must be made so that results are representative of the media and conditions being measured. Secondly, results must be expressed in units allowing comparison of data with information generated from similar studies, normally mg/L for liquids and µg/g for solids.

2.2.5 Application of the QA Objectives to "Solids"

The acid digests (of crop and livestock tissues) and water-soluble plus "plant-available" soil extracts subject to those analytical methods given in Table 2-1 will conform as a as reasonably practicable stated QA objectives. These objectives will be reasonably adapted also to those analyses requiring other instrumental methods (e.g., emission or X-ray fluorescence spectroscopy, sulfur analyzer) required during the implementation of the Work Plan.

3.0 SAMPLING PROCEDURES

Sample types generated by the Silver Bow Creek Remedial Investigation are likely to involve water, soil, tailings, vegetation, and animal tissue. This chapter describes sampling equipment, sample tampering precautions, sample shipping procedure, and field data reporting procedures required on this project.

3.1 SAMPLING EQUIPMENT

The equipment, or equivalent, described below will be required for use on this project.

3.1.1 Water Samples

3.1.1.1 Surface Water Samples

To overcome potential problems associated with collecting representative surface water samples, sampling equipment that has been specifically designed and thoroughly tested for this use will be used. The following list of sampling devices or equivalents will be used in the surface water investigation:

- US-series samplers
  - -integrating samplers (characterized in Table 3-1)
  - -pumping samplers
  - -special samplers

- Kemmerer (Forest) or Van Dorn samplers
- Pygmy (flow) meters
- Marsh-McBirney flow meters

US-seried depth integrated samplers will be used in accordance with the limitations described in Table 3-1. Use of other equipment will follow the limitations described in the following references:

- National Handbook of Recommended Methods of Water-Data Acquisition (USGS 1977);
- Characterization of Hazardous Waste Sites: Volume II, (USEPA 1983b); and
- Handbook for Sampling and Sample Preservation of Water and Wastewater (USEPA 1982c).

3.1.1.2 Ground Water Samples

Several types of sampling apparatus are available for obtaining ground water samples from various types of sources. Many factors dictate the type of sampling mechanism that is appropriate for a specific area. These include ground water quality, hydrogeologic characteristics of the ground water system, and the type of access to the aquifer of concern.

For these reasons, no single type of sampler can be used to collect representative samples from all ground water system and sources.

TABLE 3-1.--PHYSICAL CHARACTERISTICS OF US-SERIES DEPTH-INTEGRATING AND POINT-INTEGRATING SAMPLERS FOR COLLECTING SAMPLES OF WATER-SUSPENDED SEDIMENT MIXTURES

[Type: DI, depth-integrating; PI, point-integrating. Available nozzle size: A, 6.4 mm; B, 4.8 mm; C, 3.2 mm. Body material: AL, aluminum; BR, bronze; PS, plated steel]

Name	Type of sampler	Method of suspension	Mass (kg)	Overall length (in)	Available nozzle size	Sample container size (mL)	Maximum allowable depth (m)	Maximum calibrated velocity (m/s)	Distance between nozzle and sampler bottom (mm)	Body material	Remarks
US DH-48	DI	Rod	2.0	0.33	[1] A, B	473	(a)	2.7	90	[3] AL	For wading.
US DH-59	DI	Cable	10.2	.42	A, B, C	473	(a)	1.5	114	[3] BR	For hand-line operation.
US DH-75P	DI	Rod	.4	.26	B	500	(a)	2.0	83	[3] PS	For sampling only in subfreezing temperatures.
US DH-75Q	DI	Rod	.4	.29	B	1,000	(a)	2.0	114	[3] PS	Similar to US DH-75P.
US DH-76	DI	Cable	10.9	.47	A, B, C	946	(a)	2.0	80	[3] BR	Similar to US DH-59.
US D-43	DI	Cable	22.6	.52	A, B, C	473	(a)	2.1	105	BR	No longer available.
US D-49	DI	Cable	28.0	.61	A, B, C	473	(a)	2.1	103	[3] BR	
US D-49AL	DI	Cable	18.0	.61	A, B, C	473	(a)	2.0	103	[3] AL	Similar to US D-49.
US D-74	DI	Cable	28.2	.66	A, B, C	473 or 946	(a)	2.0	103	[3] BR	Similar to US D-49.
US D-74AL	DI	Cable	11.4	.66	A, B, C	473 or 946	(a)	1.8	111	(a, 4)	Similar to US D-74.
US P-46	PI	Cable	45.2	.66	B	473	42.7	3.0	122	BR	No longer available.
US P-50	PI	Cable	135.6	1.12	B	473 or 946	[5] 61.0 [6] 41.0	3.0	140	BR	
US P-61-A1	PI	Cable	47.5	.71	B	473 or 946	[5] 54.9 [6] 36.6	2.0	109	[3] BR	
US P-63	PI	Cable	90.4	.86	B	473 or 946	[5] 54.9 [6] 36.6	2.0	150	[3] BR	
US P-72	PI	Cable	17.7	.71	B	473 or 946	[5] 22.0 [6] 15.5	1.6	109	[3] AL	Similar to P-61-A1 but for hand-line operation.

[1] 4.8-mm nozzle available by special order.

[2] Varies with nozzle and container sizes as follows:

Nozzle size	Container size 473 mL	Container size 946 mL
C	5.8 m	4.9 m
B	4.9 m	4.9 m
A	2.7 m	4.9 m

[3] Available with epoxy-painted body, nylon nozzles, and silicone-rubber gaskets for trace metals.

[4] Aluminum body, bronze head.

[5] With 473-mL container.

[6] With 946-mL container.

Source: National Handbook of Recommended Methods for Water Data Acquisition (USGS 1977).

Rather, it is anticipated that several sampling apparatuses will be necessary to obtain ground water samples within the study area.

Common ground water sampling devices that may be appropriate for the Silver Bow Creek/Upper Clark Fork River study area are summarized in Table 3-2. This equipment will be used within the limitations described in Table 3-2 and in the Mannual of Ground-Water Sampling Procedures (USEPA 1981).

3.1.1.3 Decontamination of Sampling Equipment

All sampling equipment used to collect water samples will be decontaminated between samples. Methods of decontamination that will be used for various water sample types are listed in Table 3-3.

3.1.2 Tailings and Soils Sampling Equipment

Sampling equipment for use in obtaining solid samples for the Silver Bow Creek Remedial Investigation are listed in Table 3-4. This equipment will be used in accordance with the limitations described in Table 3-4.

3.1.3 Vegetation Sampling Equipment

Acquisition of vegetation samples will be accomplished with all stainless steel shears. The shears will be wiped with a Kimwipe®

TABLE 3-2.--COMMON GROUND WATER SAMPLING APPARATUSES

Sampler Type	Remarks
Bailers	Very utilitarian in many instances but may be impractical in deep or large-diameter wells.
Lift Pumps	Common types include submersible and certrifugal. Drawbacks include their bulk and awkwardness. Technology for use in small-diameter wells is just beginning.
Inert Gas Lift Pumps	Advantages include portability and ease of installation. Contact between gas and ground water, however, may change water chemistry in samples collected.
Vacuum Pumps	Portable, light, and easily adaptable to monitoring program. Requires minimum amount of downhole equipment and is easily cleaned. Major drawback is effective depth (<25 feet).

TABLE 3-3.--METHODS FOR DECONTAMINATION OF WATER SAMPLING EQUIPMENT

GRAB SAMPLES

Sample Type	Parameters	Decontamination Method
Raw Water	pH, SC, TDS, TSS, SO_4, AlK, NH_4, Cl, CN, NO_3-N, NO_2, PO_4, S^{0-2}, K_dj-N	Rinse 3 times with DI water between samples. Rinse 3 times with new sample water prior to taking sample.
Non-Filtered Acidified	Total Metals	Wash with dilute nitric acid, rinse 3 times with with DI water, rinse 3 times with sample water.
Filtered Acidified	All Dissolved Metals	Wash with dilute nitric acid, rinse 3 times with DI water, rinse 3 times with sample water.
Raw	PCP, PCB	Wash with detergent (Liquinox), rinse with DI water, rinse with hexana or petroleum naptha, air dry.

INTEGRATED SAMPLES

Sample Type	Parameters	Decontamination Method
Raw	All except PCP & PCB.	Wash with detergent, rinse 3 times with DI water, wash with dilute nitric acid, rinse 3 times with DI water.
Raw	PCP, PCB	Same as above except add petroleum naptha or hexane rinse after first DI rinse.

TABLE 3-4.--SOLID SAMPLING EQUIPMENT

Equipment	Sample Type	Limitations
Stainless Steel or Plastic Scoop or Trowl	Soil, Tailings, Exposed Sediments	Limited to surface or near surface; < 5 inches
Stainless Steel or Plastic Sampling Tier	Soils, Tailings, Exposed Sediments	Horizontal samples only. Can only sample up to 24".
Stainless Steel Soil Auger	Soils, Tailings, Exposed Sediments	For use in collecting depth integrated samples.
Stainless Steel Tube Core Samplers. Hand-Held or Veihmeyer.	Soils, Tailings, Exposed Sediments, Sediments	For use in collecting discrete depth samples, up to 16 ft. in depth.
Giddings Soil Sampler	Soils, Tailings, Exposed Sediments	For use in collecting discrete depth samples up to 25 ft. in depth.

between samples. All vegetation sampling equipment will be made of stainless steel.

3.1.4 Livestock Sampling Equipment

Stainless steel disposable needle-syringe components will be used for the acquisition of blood samples from livestock. Stainless steel shears will be used for the acquisition of hair and wool samples. The shears will be wiped with a Kimwipe® between samples.

3.1.5 Wildlife Tissue Sampling Equipment

Dissection tools will be Teflon® coated or stainless steel. Dissection trays will be Teflon® or plastic. Dissection tools and trays will be washed with dilute nitric acid and rinsed three times with DI water between each sample.

3.2 SAMPLE CONTAINERS AND SAMPLE PREPARATION

Table 3-5 lists sample containers that will be used for each sample type generated by the Silver Bow Creek Remedial Investigation. This table also lists sample volumes, sample preservation requirements, and container treatment/decontamination procedures.

TABLE 3-5.--SAMPLE CONTAINERS, PRESERVATION, AND HOLDING TIME

Sample Matrix	Parameters	Preservation Technique[1]	Container	Volume of Sample	Field Decontamination Technique	Holding Time[2]
Water	pH, SC, TDS, TSS, SO_4^{-2}, Alk, Cl^-, Fl^-, NO^{-3}, NO_2^-	Cool to <4°C	2-1 qt. cubes	Fill Containers	Rinse 3 times with sample	7 days (24 hours for NO_3^- and NO_2^-)
Water	NH_4^+, Kheldahl N, Total P, COD	H_2SO_4 < pH 2 Cool to < 4°C	32 oz poly	Fill Container	Rinse 3 times with sample	24 hours for Total P, 28 days for others
Water	Ortho PO_4^{-3}	Filter to <.45 micron, Cool to < 4°C	8 oz narrow mouth poly bottle	Fill Container	Rinse 3 times with filtered sample	48 hours
Water	S^{-2}	2 mls Zinc Acetate, NaOH to > pH 9 Cool to < 4°C	16 oz poly bottle	500 ml	Rinse 3 times with sample	7 days
Water	Dissolved Metals and Hardness	Filter to < .45 micron, 2 ml HNO_3 Cool to < 4°C	8 oz wide mouth round poly bottle	200 ml	Rinse 3 times with filtered sample	6 months
Water	Total Metals	2 ml HNO_3, Cool to < 4°C	8 oz square poly bottle	200 ml	Rinse 3 times with sample	6 months
Water	BOD	Cool to < 4°C	1 qt. cube	Fill Container	Rinse 3 times with sample	48 hours
Water	Coliforms	Cool to < 4°C	Prepared Whirl-pak®	To Mark	None	6 hours

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TABLE 3-5.—SAMPLE CONTAINERS, PRESERVATION, AND HOLDING TIME

Sample Matrix	Parameters	Preservation Technique[1]	Container	Volume of Sample	Field Decontamination Technique	Holding Time[2]
Water	PCP	H_2SO_4 to < pH 2 Cool to < 4°C	32 oz clear glass with aluminum foil lined cap	1 L	Rinse 3 times with sample	24 hours
Water	PCB	Cool to < 4°C	32 oz amber glass with aluminum foil lined cap	1 L	No pre-collection rinse	Extracted in 7 days. Analyzed within 30 days
Water	Oil and Grease	H_2SO_4 to < pH 2 Cool to < 4°C	32 oz glass with foil lined cap	1 L	Rinse 3 times with sample	28 days
Water	Cyanide	NaOH to pH > 12 Cool to < 4°C	32 oz poly bottle	1 L	Rinse 3 times with sample	14 days
Tailings	All	Cool to < 4°C	Two 42 oz Whirl-pak® bags	Fill bags (1 kg each)	N.A.	N.A.
Vegetation	All	Cool to < 4°C	Paper Lunch Bag	0.5 kg	N.A.	6 months
Soil	All except N	Cool to < 4°C	42 oz Whirl-pak®	Fill Bag 1 kg	N.A.	6 months

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TABLE 3-5.--SAMPLE CONTAINERS, PRESERVATION, AND HOLDING TIME

Sample Matrix	Parameters	Preservation Technique[1]	Container	Volume of Sample	Field Decontamination Technique	Holding Time[2]
Livestock Blood	All	Cool to < 4°C, ammonium heparin	10 ml monovent	4 monovents ea. at 10 ml in Whirl-pak®	N.A.	6 months
Livestock Hair	All	Cool to < 4°C	2 oz Whirl-pak® bag	Three 2 oz Whirl-paks® with < 4 gm/bag for < 12 gm sample	N.A.	6 months
Wildlife Tissue	All	Cool to < 4°C then freeze	18 oz Whirl-pak® bag	Whole organ or sample	N.A.	6 months

a) Source: USEPA 1983b.

Updated 11/2/85 MDR

3.3 SAMPLE TAMPERING PRECAUTIONS

Proper chain-of-custody procedures will negate the requirement for individual sample tampering precautions for those samples not shipped. For samples that are shipped using common carriers, sample shipping containers, described in the section below, will be taped in such a way that opening the shipping container will be indicated. If the receiving lab has reason to believe the sample shipping container has been opened during transit, the samples will be analyzed as directed, but will note on all report forms that integrity may have been lost.

3.4 SAMPLE IDENTIFICATION

Samples will be identified with standardized sample labels that will be filled out with a waterproof indelible pen at the time of sampling. The recommended label is shown in Table 3-6. These labels were designed for all the information the study objectives dictate, and all information necessary for effective sample tracking. The information includes:

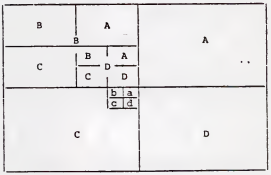
- Sampling Identification Number (Station/Date);
- Name of Sampling Organization;
- Name of Sampler
- Time;
- Sample Type;
- Location Description;

TABLE 3-6.--SAMPLE IDENTIFICATION TAG

TAG NO.										
	SBC-				N	W				
	Station		Date	No.	T	R	S	1/64S	No.	
	Sample Type:				Comp.	Int.	Grab			
	Preservative:				Time:					
	Sampler(s):									
	For:									
	Comments:									

Instructions

Station	SSXXX	Surface Water Stations
	GWXXX	Ground Water Stations
	PSXXX	Point Source Station
Date	XXXXXX (Month, Year, Date)	
No.	XX	Sample Number for a station sampled several times on the same day.
T	XX	Township N
R	XX	Range W
S	XX	Section 1-36
1/64S	XXXX	1/64 Section Use
No.	Sample Number for more than one sample from a 10 acre site.	



Sample Type = Water, Soil, Tailings, Vegetation, Tissue
Circle Appropriate Method.

Preservative: Indicate Preservative Used.

Time: Indicate Time of Sample Acquisition (military time).

Sampler(s): Names of Sampler(s).

For: Organizations of Sampler(s).

Comments: Additional notes regarding sample.

Tag Number: Pre-numbered Tags - under document control by the Sample Bank.

- Preservative; and
- Comments.

Sampling station numbers will be assigned initially and maintained throughout the study. The station numbers will be cited on all samples and information obtained from the site.

3.5 FIELD NOTEBOOKS

Field notebooks with numbered standardized field note forms will be utilized during all sampling activities. Entries will include sufficient detail to reconstruct sampling activities without reliance on memory. Information detail will include but is not limited to:

- Sample Identification Number;
- Date;
- Time;
- Weather conditions;
- Field personnel present;
- Field personnel making entry;
- Station number/Location (TRS 1/64S);
- Observation remarks about site. (Type of well, size of well, appearance of sample, etc.);
- Results of field measurements (e.g. pH, specific conductance);
- Discharge measurement values
- Description of how and where discharge measurement were taken;
- Description of the samples collected and how they were

collected;

- Number, volume, and types of samples taken;
- Description of any quality control samples taken;
- Identification of all equipment used to make measurements and their most recent calibration date;
- Sample distribution; and
- Assigned laboratory number.

All entries will be made in waterproof ink with no erasures. If an incorrect entry is made, the information will be crossed out with a single strike mark, initialed, and dated.

3.6 FIELD QA/QC SAMPLES

Two types of field QA/QC samples will be generated by the field sampling crews. One of every 40 samples of all types will be a field blank, which will consist of reagent grade deionized water treated in the same manner as the sample (i.e., filtered and acidified). One of every 20 samples will be a field duplicate, which will consist of a second sample, replicating the conditions, location, time of sampling, and treatment of the first.

3.7 SAMPLE SHIPMENT

Samples requiring shipment will be shipped according to the specifications found in Appendix C of Characterization of Hazardous Waste Sites - A methods Manual by USEPA (1983b).

4.0 CREATION AND IMPLEMENTATION OF THE SAMPLE BANK

4.1 SAMPLE BANK'S PURPOSE AND RESPONSIBILITIES

The sample bank is responsible for record filing and storing, for storing and preparation of all sample matrix types, and for dispensing containers, sampling equipment, and all custody documents such as chain-of-custody forms and sample collection and analytical tags.

The sample bank is responsible for completing, as required, analysis data reporting forms and for assuring that all chain-of-custody requirements as stated in [Section 4.0 of this report], pertaining to all field sampling, shipping and sample bank operations, are adhered to.

Each contractor laboratory involved in this project will establish a sample bank, subject to review and approval by the MDHES Remedial Site Project Officer.

4.2 PROCEDURES

4.2.1 Issuing Supplies

- As appropriate, the sample bank will issue sample containers, sample collection tags, and chain-of-custody forms to the

sampling teams. As the sample collection tags and chain-of-custody form are accountable documents, the sample bank will log the forms by numerical lot identifying the team and/or the individual responsible for the temporary custody of these documents.

- The sample bank may be required to store sampling equipment in a suitable environment. If sampling equipment is stored at the sample bank, issuing this equipment to the sampling teams will be recorded by the Sample Bank.

4.2.2 Acceptance and Logging In Of Samples

- Transfer of sample custody from the sampler to sample bank personnel will normally occur at the sample bank.

- Before accepting custody of any samples, sample bank personnel will check all tags and forms for legibility and completeness.

  (a) All individual samples must have a completely filled out sample collection tag attached.

  (b) Every sample must be identified on the chain-of-custody form.

(c) Each sample must have a complete analysis request form. Responsibility for filling out this form lies with the field crew leaders. These forms are described in Section 7.0.

(d) Any discrepancy will be corrected before the sample bank personnel will assume custody.

(e) All unused accountable documents must be returned to the sample bank. Depending upon circumstances such as a sampling team's schedule and route, accountable documents may be retained by the sampling team leader.

- After the sampler relinquishes custody and the sample bank personnel assumes custody of the samples, each sample will be logged into the master log book. The master log book will be a suitable ledger with column headings, similar to those shown in Table 4-1. The ledger shall be a hard bound water resistant notebook. Additional headings may be required as the program develops; thus, blank columns should be available in the ledger.

4.2.3 Laboratory Numbering Scheme for the Samples

All samples shall be assigned laboratory numbers by the Sample Bank. These numbers shall have a designator for sample type (i.e., S for

TABLE 4-1.—MASTER LOG BOOK HEADINGS, SHOWING HYPOTHETICAL ENTRIES FOR SOIL SAMPLES

Sample Bank No.	Sample Collection Tag No.	Date Collected	Media	Chain-of-Custody Form No.	Analytical Laboratory (Initial)	Date Sent to Analytical Laboratory	Chain-of-Custody Form No. to Analytical Laboratory	Remarks
S00001	241516AAAA	14 May 84	Surface Soil (0-4 in)	00001	C.W.	15 May 84	01082	No triplicate split made
S00002		14 May 84	"	"	C.W.	—	—	1/4 split for later reference
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮
S00121		16 May 84	Surface Soil (0-4 in)	00006	C.W.	17 May 84	01102	Triplicate split made
S00121		16 May 84	"	"	C.W.	18 May 84	01103	Mailed out to EPA in A.M.
S00121		16 May 84	"	"	C.W.	18 May 84	01104	Mailed out to contract laboratory in A.M.
S000122		16 May 84	Surface	0006	C.W.	—	—	1/4 split for late reference
⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	

soil) followed by five digits (i.e., 00001) sequentially numbering the samples as they are received.

- The log book will be arranged in such a manner as to log media in groups. For example, all soils will be logged together.

- After assigning a sample bank number to the [particular] sample and recording the proper information into the log book, the laboratory tag with the sample bank number will be placed on the sample container. The sample is then ready for further preparation or analysis.

- When samples are to be shipped to a referee lab, the initials of the analytical laboratory to which the sample is to be sent and the date the sample was shipped will be recorded in a separate log book.

- The chain-of-custody form, (Figure 5-1), identifying the analytical laboratory to which the samples are to be sent, the sample bank number of each sample in the shipment, the sample description, and any remarks concerning the sample that are appropriate, will be completed. The chain-of-custody form number will be recorded in the log book.

- A computerized logging system providing immediate hardcopy and equivalent documentation of sample receipt may be

substituted with provided approval of the MHDES QA officer.

The following documentation forms and their disposition for each sample from collection to the analytical laboratory is as follows:

Form	Disposition
1. Sample Collection Tag	Filed at Sample Bank
2. Site Description Form	Filed at Sample Bank
3. Sampler Chain-of-Custody Form	Original filed at Sample Bank, Copy to Originator of Sample
4. Master Log Book	Filed at Sample Bank
5. Analytical Tag	Analytical Laboratory's Files
6. Chain-of-Custody Form (Sent to Analytical Laboratory)	Original to Analytical Laboratory, Copy to Sample Bank's Files
7. Data Reporting Form (with Site I.D. No.)	Original to Sample Bank Copy to Originator of QC Sample
8. Shipping Form	Original to Analytical Laboratory, Copy to Sample Bank

4.2.4 Numbering Scheme for the Quality Control (QC) Samples

- Field quality control samples will be sent to the sample bank accompanied by chain-of-custody forms. These samples will be appropriately identified by sample description and concentration.

- These field QC samples will be given a sample bank number beginning with the capital letter N. The remaining five

digits will be numbers beginning with 00001; i.e., the first Quality Control sample logged into the log book will be N00001, the second N00002, etc.

- These field QC samples will be logged in, documented, and shipped identically to procedures previously identified.

- The originator of the field QC sample will be responsible for filling out the sample analysis request form.

The sample bank will number Sample Bank-generated QC samples as follows:

QB0001 will denote a reagent blank
QS0001 will denote a laboratory control standard or spike
QA0001 will denote splits and duplicates

These sample bank numbers will be logged into the log book in the QC section. Also, these sample bank numbers should be logged in numerical order by category, i.e., QB0001, QB0002, etc.

- The sample bank personnel will generate sample bank QC samples according to the schedules presented in Table 4-2.

4.2.5 Preparation of QC Samples

Table 4-2 lists all QC samples required for this project. Table 4-3

TABLE 4-2.—SCHEDULE OF FIELD GENERATED AND SAMPLE BANK GENERATED QC SAMPLES

TYPE OF QC SAMPLE	MATRIX				
	Water[1]	Soil[1]	Tailings[1]	Vegetation[1]	Tissue[1,2]
Field Duplicate	1/20	1/40	1/40	1/40	1/40 muscle 2/20 blood
Field Blank	1/40	1/40	1/40	1/40	1/40
SB Reagent Blank	1/40	1/40	1/40	1/40	1/40
SB Spike (Straight, Extract or Total Digest)	1/40	1/40	1/40	1/40	1/40
SB Standard (NBS-SRM)	1/40	1/40	1/40	1/40	1/40
SB Spike Duplicate	0/40	0/40	0/40	0/40	1/40
SB Blind Split (of Original Processed Material)	0/40	1/40	1/40	1/40	1/40
Referee Lab Duplicate	1/40	1/40	1/40	1/40	1/40
SB Split Extract (Partial)	N.A.	1/40	1/40	0/40	0/40
SB Split Digest (Total)	1/40	1/40	1/40	1/40	1/40
Lab Calibration Standards[3]	1/10	1/10	1/10	1/10	1/10
Lab Spikes	1/10	1/10	1/10	1/10	1/10
Lab Replicate Analyses	1/10	1/10	1/10	1/10	1/10

1 Spikes for some measurements are inappropriate.

2 As appropriate, whole tissues will not have duplicates.

3 Mid-range calibration check.

TABLE 4-3.--QC SAMPLE DEFINITIONS

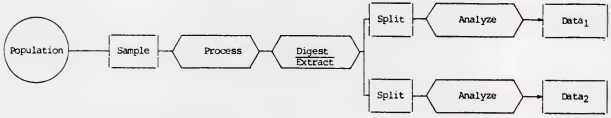
QC Sample Type	Where Generated	Definition
Field Duplicate	Sampling Site	A second sample is acquired from the sampling location. Data are used to evaluate precision.
Field Blank	Sampling Site	A sample of DI water is prepared in the same manner as the environmental sample. Data are used to assess potential contamination.
SB Reagent Blank	Sample Bank (not blind to analyst)	A sample is prepared for analysis using only preparation and/or digestion reagents. Data are used to assess for contamination and for blank subtractions.
SB Spike	Sample Bank	A spike of known concentration is added to an unknown. Type of spike and point in processing is shown in Figure 4-2. Data are used to evaluate accuracy.
SB Standard	Sample Bank	An NBS-SRM is processed, digested, or extracted and submitted to the analysts. Data are used to evaluate accuracy.
SB Spike Duplicate	Sample Bank	This is a special case for blood samples. As these samples arrive at the sample bank as a set of four duplicates, one of the four is spiked and submitted for analysis. Data are used to evaluate accuracy.
SB Blind Split	Sample Bank	An unknown is split prior to processing or digesting/extracting. Data are used to evaluate precision.

TABLE 4-3.—QC SAMPLE DEFINITIONS

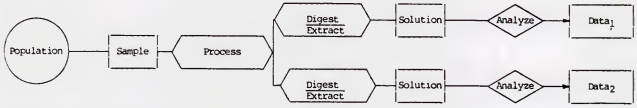
QC Sample Type	Where Generated	Definition
SB Split Extract	Sample Bank	An unknown is split following extraction. Data are used to evaluate precision.
SB Split Digestion	Sample Bank	An unknown is split following digestion. Data are used to evaluate precision.
Lab Calibration Standard	Analytical Lab	A mid-range standard is measured during batch runs. Data are used to maintain calibration during analysis.
Lab Spikes	Analytical Lab	A spike is added to the unknown by the analyst. Data are used to immediately measure recovery efficiencies of analysis (accuracy).
Lab Replicates	Analytical Lab	The analysts remeasures an unknown a second time following batch run. Data are used to immediately measure analysis precision.
Referee Lab Duplicate	Sample Bank	An unknown is split prior to processing or digesting/extracting. One of the splits is shipped to a referee lab for processing, digestion/extracting, and analysis. Data are used to evaluate precision.

FIELD DUPLICATE

SB DIGEST/EXTRACT SPLIT

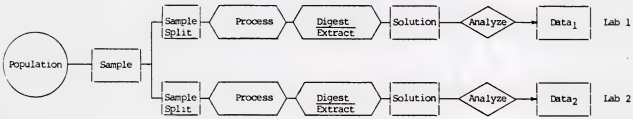


SB BLIND SPLIT (OF PROCESSED MATERIAL)



LAB REPLICATE

REFEREE LAB DUPLICATE

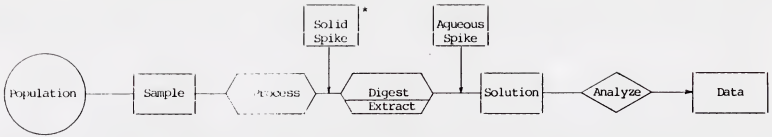


Duplicate Agreement Factor

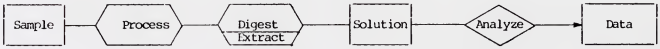
$$DAF = \frac{d_1}{(d_1 + d_2)/2} \quad (100)$$

* Water samples are not processed. Only total metals analyses require digestions of water.

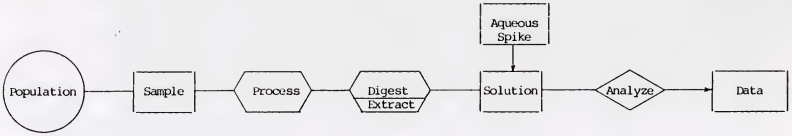
SB SPIKE



NBS STANDARD



LAB SPIKES



*Applies only to total digests of solid materials.

Accuracy = A

$$A = \left(\frac{X - T}{T}\right) 100$$

Where T = True Value
X = Measured Value

FIGURE 4-2.--QC SAMPLES FOR ACCURACY EVALUATIONS

defines each QC sample type. Figures 4-1 and 4-2 illustrate the process of QC sample preparation. QC samples are generated by field personnel (duplicates and blanks) and sample bank personnel (blanks, splits, standards, and spikes). Lab personnel generate QC data with lab replicates, lab spikes, and calibration checks.

5.0 CHAIN-OF-CUSTODY PROCEDURES

5.1 INTRODUCTION

Custody records trace a sample from its collection through all transfers of custody until it is transferred to an analytical laboratory. Internal laboratory records then document the custody of the sample through its final disposition. Individuals generating samples for the Silver Bow Creek Study will be required to complete custody records.

In order to establish that a sample is valid, it is also necessary to document the measures taken to prevent and/or detect tampering. This applies both to the sample itself and the sampling equipment used. Documented or suspected tampering is to be described and recorded in the appropriate field, laboratory logbooks, or chain-of-custody forms. The MDHES State Project Officer (SPO) should be notified immediately.

The sample bank will provide and dispense sample tags, custody records, logbooks, data sheets, etc., as appropriate; thus, document security will be assured. The role of the sample bank in maintaining quality control/quality assurance is discussed in Section 3.8 of this document.

Analytical contractors shall identify a person responsible for chain-of-custody matters.

5.2 FIELD SAMPLING EQUIPMENT AND SAMPLE

Custody field sampling equipment and samples stored at the Sample Bank shall be locked in an area with a documentable access roster.

5.3 SAMPLE TRANSFER PROCEDURES AND CHAIN-OF-CUSTODY RECORDS

Once a field sample is generated, handling and transfer procedures must adhere properly to chain-of-custody requirements. These custody procedures are initiated in the field and will be complied with until the final fate of the particular sample has been achieved.

Chain-of-Custody Records

A record of sample possession is necessary to trace custody of each sample collected. This record is important especially if a sample is to be introduced as evidence in court litigation. Chain-of-custody records are forms that are filled out upon each exchange of sample possession and which always accompany the samples. The required chain-of-custody record is shown in Figure 5-1.

5.4 QUESTIONS/PROBLEMS CONCERNING CUSTODY RECRODS

The recipient (of a given set of samples) will document completely any discrepancy or deviation from the chain-of-custody procedures. Every effort will be made to clarify, then rectify, the situation

CHAIN OF CUSTODY RECORD

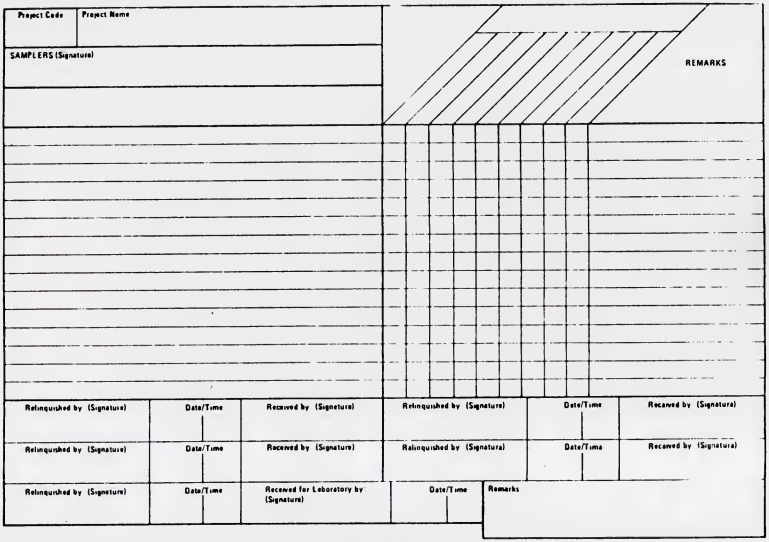


FIGURE 5-1.--CHAIN-OF-CUSTODY REPORT (USEPA 1983b)

existing between the originator and recipient (of sample custody) prior to analyzing the samples. When the problem cannot be resolved by these individuals, the MDHES SPO will be contacted. The three (or more) involved parties will then develop a mutually acceptable course-of-action, thus solving the various problems and concerns previously encountered.

5.5 LABORATORY/SAMPLE BANK CUSTODY PROCEDURES

The laboratory shall designate a sample custodian. An alternate will be designated in his/her absence. In addition, the laboratory shall set aside a sample storage security area. This should be a clean, dry, isolated room which can be securely locked from the outside, (described in Section 4.2). This area also includes refrigerators for storage of chilled samples. These collective areas are called the sample bank.

All incoming samples shall be received only by the custodian, who will indicate receipt by signing the Chain-of-Custody Record Sheet accompanying the samples and retaining the sheet as permanent records. Couriers picking up samples at the airport, post office, etc., shall sign jointly with the laboratory custodian. Immediately upon receipt, the custodian will place the sample in the sample room. The sample room shall be open only to those persons with documentable access.

Laboratory personnel are responsible for the care and custody of the sample, and should be prepared to testify that the sample was in their possession and view or secured in the laboratory at all times from the moment it was received until the tests were run.

Once the sample testing is completed, the unused portion of the sample together with all identifying tags and laboratory records, should be returned to the custodian or sample bank. The returned tagged sample will be retained in the sample room until it is required for further analyses. Strip charts and other documentation of work will also be turned over to the custodian.

6.0 INSTRUMENT CALIBRATION

6.1 FIELD INSTRUMENTS

All instruments used in the field to collect data during water sampling will be calibrated with reference solutions and/or standard reference materials on a routine basis. The required schedule of field instrument calibration is shown in Table 6-1.

The standards will be obtained from a reliable source such as a certified laboratory, the U.S. EPA, the National Bureau of Standards, or the U.S. Geological Survey. The standards will be handled, and stored, in an appropriate manner to prevent decay and contamination. They will be replaced routinely and whenever contamination is suspected.

6.2 LABORATORY INSTRUMENTS

6.2.1 Analytical Balance

The analytical balance shall be calibrated according to the following instructions.

Weigh a set of class S weights ranging from 1 to 100 g on the analytical balance(s) used during this study at the beginning of the study and repeat every 21 days. If any of the readings do not agree within ± 0.2 mg with the stated value, recalibrate the

TABLE 6-1.—SCHEDULE OF FIELD INSTRUMENT CALIBRATION

Instrument	Required Calibrations
pH Meter	1) Calibrate according to manufacturer's recommendations prior to and following each day's sampling. 2) Check 7.0 standard prior to each sample measurement.
Specific Conductivity Meter	1) Determine probe factor using a KCl standard having a conductance in approximately the same range as samples at least for each sampling day. 2) Make "red-line" check prior to and following each measurement. 3) Calibrate temperature probe with an NBS thermometer once a week.
Dissolved Oxygen Meter	1) Calibrate with Winkler method once a month. 2) Calibrate with saturated water method prior to and following each day's sampling. 3) Calibrate with saturated air method once before each measurement.
Well Probe	1) Calibrate at project initiation and once per month with steel engineers tape.
Flow Meters	1) Calibrated according to manufacturer's instructions at project initiation and once per month thereafter. 2) Spin tests prior to and following each measurement.
Continuous Recorders	1) Calibrated according to manufacturer's instructions upon installation and once per month thereafter.
Continuous Samplers	1) Calibrated according to manufacturer's instructions and once per month thereafter.
Thermometers	1) Calibrate once per month with NBS thermometer.

balance. Record the results of all balance checks in the balance log book. A calibration shall also be performed whenever the analytical balance has been moved or has been subjected to rough handling or to cleaning.

6.2.2 Atomic Absorption Spectrophotometer and UV-VIS Spectrophometer

Calibrate with a minimum of a reagent blank and three standards encompassing the concentration range of interest. At least one standard should be below the maximum contaminant level (MCL). Calibrate at least once for each day on which analyses are performed.

The calibration curve shall be calculated by a polynomial least squares fit of the calibration data such that the degree of the polynomial is not greater than one less than the number of standards. The calibration curve must account for at least 90% of the absorbance variation of the standards. More rigorous calibration criteria may be used if desired.

Calibration checks must be run at a frequency of 5%, or once for each day on which analyses are performed, whichever is more frequent. Calibration checks must be within 10% of the calibration curve.

6.2.3 ICP Emission Spectrometer

Instrument calibration and calibration checks shall be done as specified in EPA Method 200.7 (USEPA 1983a).

6.2.4 Other Electronic Instrumentation

The calibration of other electronic instrumentation shall be performed as listed in Table 6-2. In all cases calibration procedures must be consistent with good professional practice.

TABLE 6-2.—LABORATORY INSTRUMENT CALIBRATION SCHEDULE

Instrument	Required Calibrations
Leco® Sulfur Analyzer	1) Calibrate at beginning of each batch according to manufacturer's instructions.
pH/Redox/Specific Ion Meters	1) Calibrate at beginning of each batch according to manufacturer's instructions.
Gas Chromatographs	1) Calibrate at beginning of each batch according to appropriate EPA Method.
Ion Chromatographs	1) Calibrate at beginning of each batch according to manufacturer's instructions.

7.0 LABORATORY ANALYTICAL PROCEDURES

7.1 ANALYTICAL LABORATORY GENERAL QC PRACTICES

7.1.1 Preparation of Laboratory Ware

Labware should be prepared by, at minimum washing in laboratory detergent and hot water, rinsing three times with tap water, once with 1:1 nitric acid (ACS reagent grade or better), and three times with deionized water. Air dry and store so as to minimize contamination from dust or other sources.

Labware used for organic samples may require additional or different cleaning procedures; see appropriate EPA Method.

Labware has been satisfactorily cleaned only if acceptable blanks are obtained.

7.1.2 Standard Stock Solutions

Stock standard solutions may be purchased from commercial sources or obtained from EPA, if available, or prepared according to prescribed methods (USEPA 1983a, USEPA 1982a, APHA, 1980). All stock standards must be dated. 1000 mg/L metal standards may be used for up to one year from date of receipt or preparation. Other standards amy have shorter preservation times; see appropriate EPA Method.

100 mg/L metal standard solutions may be used for up to one month, other diluted standards will have shorter preservation times; see appropriate EPA Method. Standards at less than 100 mg/L generally should be prepared fresh before each use.

Standards not within ±10% of EPA quality check samples should be discarded.

7.2 ANALYSIS METHODS

EPA approved methods will be used whenever possible. These methods are listed in Section 2.0. For those analyses for which there are no approved EPA methods, the Project Work Plan describes the required methodology. These non-EPA approved methods shall be documented by the laboratory.

7.3 RECORDS MAINTENANCE AND REPORTING

Records of chemical analyses will be kept by the laboratory for at least three years. These records include all raw data, calculations, and QC data. However, with the exception of compliance check samples, such information may be summarized to tabular form to meet this requirement, (U.S. EPA 1982c). The required data will be taken from the sampling logs, chain-of-custody records, and the laboratory record sheets. These protocols are generally applicable to microbiological and radiochemical analyses, except that the former data must be available for five years.

7.4 INTEGRATION OF QC SAMPLES WITH UNKNOWNS

Field and sample bank generated QC samples will be integrated into an analysis batch by the sample bank. The analyst shall perform the required measurements on the batch provided by the sample bank in the order provided by the sample bank.

8.0 DATA HANDLING, MANAGEMENT, AND REPORTING

8.1 DATA HANDLING

8.1.1 Sampling Associated Records

Sample bank personnel will review the field sampling associated records that are received along with the samples. The forms will be archived only after the sample bank supervisor accepts them as being accurate and complete. The associated chain-of-custody procedures are described in Section 5.0. The master of each completed form is then retained at the bank, while a copy is retained by the sampler. It is suggested also that all developed and undeveloped photographic imagery (e.g., color slides) be stored in the sample bank.

8.1.2 Laboratory Data Sheets

The sample bank will provide standard analytical request forms to the field sampling personnel for their completion. These will be designed in an 80-column format for direct keypunching of reported information. The report form used commonly by MultiTech are shown in Figures 8-1 through 8-5. The request/reporting forms for laboratory data will be coded at the sample bank (prior to release to the various contractor laboratories) so that all appropriate sample record numbers are entered. Each analytical laboratory involved in this project will encode its own data.

FIGURE 8-1.--MULTITECH'S WATER QUALITY/AQUATIC ANALYSIS REPORT FORM

WATER QUALITY/AQUATIC ANALYSIS REPORT

Laboratory No._____ Date Submitted_____

Field No._____ Station Ident._____

Matrix Type (circle one): Surface Water Snow Macrophyte
Groundwater Algae Sediments
Other_____

FIELD MEASUREMENTS:

D.O._____(ppm) Temp._____(^{o}C)

Discharge_____(cfs) pH_____

PHYSICAL ANALYSIS:

Turbidity_____(_____ Units), Conductivity_____(___ m hos/cm, 25^{o}C)

Texture_____(% sand/silt/clay, by hydrometer)

Parameter	Mean	RSD	95% C.I.	Units
Color			/	Color Units
Soluble Solids			/	Mg/ℓ
Filtered Solids			/	Mg/ℓ
Total Solids			/	Mg/ℓ

BIOLOGICAL ANALYSIS:

___	Biochemical Oxygen Demand	_____(mg/ℓ)
___	Total Coliform	_____(no./100 mℓ)
___	Fecal Coliform	_____(no./100 mℓ)
___	Fecal Strept	_____(no./100 mℓ)
___	Periphyton Biomass	_____(g/cm^2)
___	Periphyton Inventory Submitted?	_____ YES _____NO
___	Macroinvertebrate Inventory Submitted?	_____ YES _____NO

CHEMICAL ANALYSIS:

___	Total Alkalinity _____(mg/ℓ)	___	Total Hardness_____(mg/ℓ)
___	Bicarbonate Alkalinity_____(mg/ℓ)	___	Ca Hardness _____(mg/ℓ)
___	Carbonate Alkalinity _____(mg/ℓ)	___	Mg Hardness _____(mg/ℓ)
___	Hydroxide Alkalinity _____(mg/ℓ)		

Parameter	Mean	RSD	95% C.I.	Units
Ammonia N			/	
Nitrate N			/	
Fluoride			/	
			/	
			/	

Parameter	Mean	RSD	95% C.I.	Units
Phosphate			/	
Chloride			/	
Iron			/	
Sulfate			/	
			/	

FIGURE 8-1.--MULTITECH'S WATER QUALITY/AQUATIC ANALYSIS REPORT FORM (CONTINUED)

WATER QUALITY/AQUATIC ANALYSIS REPORT

Laboratory No._____

TRACE ELEMENTS (circle one): Total Std. Filtrate 45μ Filtrate Other

ELEMENT	Mean	RSD	95% C.I.	Units
Ag			/	
Al			/	
As			/	
B			/	
Ba			/	
Be			/	
Bi			/	
Ca			/	
Cd			/	
Co			/	
Cr			/	
Cu			/	
Fe			/	
Hg			/	
K			/	
Mg			/	
Mn			/	
Mo			/	
Na			/	
Ni			/	
P			/	
Pb			/	
Sb			/	
Se			/	
Sn			/	
Sr			/	
Ti			/	
V			/	
Zn			/	
Zr			/	

OTHER ANALYSIS:

Analysis	Mean	RSD	95% C.I.	Units

Analysts_____

_____

_____

_____

Lab Dir. Approval_____

Report Date_____

Comments:

Project Leader Approval for Computer Input_____

Date:_____

FIGURE 8-2.—ATOMIC ABSORPTION SPECTROSCOPY QC/QA ANALYSIS FORM
(CONTINUED)

Date__/__/____

Analyst(s)_____

Data (Continued):

	Element =						Element =				
LAB #	Dil'n Fact.	Conc. A	Conc. B	Conc. C	Spike Conc. ( ) or Std. #	LAB #	Dil'n Fact.	Conc. A	Conc. B	Conc. C	Spike Conc. ( ) or Std. #

FIGURE 8-2.--ATOMIC ABSORPTION SPECTROSCOPY QC/QA ANALYSIS FORM

Date / /

Analyst(s)

Instrument Model/Make Used:

Instrument Conditions: Flame Furnace Hydride Cold Vapor

Element/Wavelength: / nm. Std. Ref. No.

Comments: (e.g., fuel/oxidant flow rates, char-ash ramp times for furnace, absorption mode and integration time, background correction, etc.)

QC Data:

Unknowns:
- Container type
- Preservative used
- Holding Time (Days/Hours)

Reagent Blanks (Initial Readings)
- 1st run µg/ml.
- 2nd run µg/ml.
- 3rd run µg/ml.

Knowns:

Std. 1 2 3 4 5 6

Prep. Concs. (µg/ml.)

Absorbance (A)

Calculated Detection Limits:
- Mean D. L. µg/ml.
- Std. MDL. µg/ml.

Data:

LAB #	Element = Dil'n Fact.	Conc. A	Conc. B	Conc. C	Spike Conc. ( ) or Std. #	LAB #	Element = Dil'n Fact.	Conc. A	Conc. B	Conc. C	Spike Conc. ( ) or Std. #

FIGURE 8-3.—BIOLOGICAL/TERRESTRIAL MONITORING ANALYSIS REPORT

Laboratory No._____ Date Submitted (to Lab)_____

Field No._____ Station Identification_____

Matrix Type (Circle One): Soil 0-5 cm, Soil 15-20 cm, Other_____, Vegetation, Moss, Animal, Rock

I PHYSICAL/BIOLOGICAL ANALYSIS

____	Biomass	(g/m^2)
____	Berlese Funnel	Yes____ No____
____	Moisture	(%)
____	Texture	(% sand/silt/clay, by hydrometer)

II CHEMICAL ANALYSIS

____	Radioactivity	(μCi/ml)
____	pH	(standard units)
____	Redox Potential	(millivolts)

	Mean	RSD	95% C.I.	Units
Sulfate				
Total Fluoride				
Total Nitrogen				
Nitrate				
Total Sulfur				

		Trace and Non-Trace Elements							
			Acid Digestion ("Totals")				Bio-Available ("Partials")			
	ELEMENT	Mean	RSD	95% C.I.	Units	Mean	RSD	95% C.I.	Units
	Ag								
	Al								
	As								
	B								
	Ba								
	Be								
	Bi								
	Ca								
	Cd								
	Co								
	Cr								
	Cu								
	Fe								
	Hg								
	K								
	Mg								
	Mn								
	Mo								
	Na								
	Ni								
	P								
	Pb								
	Sb								
	Se								
	Sn								
	Sr								
	Ti								
	V								
	Zn								
	Zr								

OTHER ANALYSIS:

Analysis	Mean	RSD	95% C.I.	Units

Analysts_____

Lab Director Approval_____
Report Date_____

Comments:

Project Leader Approval for Computer Input_____
Date_____

FIGURE 8-4.—PROPOSED ADDITIONS TO THE LABORATORY ANALYSIS REPORT FORM USED PRESENTLY BY MULTITECH

BIOLOGICAL/TERRESTRIAL MONITORING ANALYSIS REPORT

Laboratory No._____ Page _____of_____

III RECLAMATION-RELATED PARAMETERS

A. Physical Parameters

|___| Bulk Density by (method)_____. Results:_____ ± _____ gm/cm^3 (N =_____).

|___| Clay Mineralogy by (method)_____. Results (% w/w):
Chlorite_____, Illite_____, Kaolinite_____, Montmorillonite_____,
Smectite_____, Vermiculite_____, Other (Specify)_____.

|___| Electrical Conductivity by (method)_____.
Results:_____ ± _____ decisiemens/meter @ 25° C, (N =_____).

|___| Saturated Hydraulic Conductivity by (method)_____.
Results:_____ cm/hr with ΔK = _____ (N =_____).

|___| Saturation Percentage by (method)_____. Results:_____%.

|___| Water Retention Capacity by (method)_____.
Results:_____% @ 1/10 Bars, _____% @ 1/3 Bars, _____% @ 15 Bars

B. Chemical Parameters

|___| Calcium Carbonate Equivalent by (method)_____.
Results:_____ ± _____ eq. % (N =_____).

|___| Cation Exchange Capacity by (method)_____.
Results:_____ ± _____ mmole/kg (N =_____).

|___| Exchange Acidity by (method)_____.
Results:_____ ± _____ mmole/kg (N =_____).

|___| Exchangeable Sodium Percentage (by calculation)_____%

|___| Gypsum by (method)_____.
Results:_____ ± _____ meq/100 grams (N =_____).

|___| Organic Carbon by (method)_____. Results:_____ ± _____% (N =_____)

|___| Sulfide by (method)_____. Results:_____ ± _____ mg/Kg (N =_____)

C. Biological Parameters

|___| Biomass by (method)_____. Results:_____ (units)

|___| Enzymatic Activity by (method)_____. Results:_____
_____(units).

D. Other Parameters

|___| Parameter 1)_____(units)

|___| Parameter 2)_____(units)

FIGURE 8-5

SILVER BOW CREEK SUPERFUND STUDY

SOIL SAMPLE QUALITY ASSURANCE

Report To:_____ Date Reported:_____

Distribution:_____ QC Report #:_____

_____ Sample #'s: (Sequence as Analyzed)

_____ _____

_____

Laboratory Name:_____

Laboratory Supervisor:_____ Analyst(s) Initials:_____

1. Reagent Blank: µg/ml_____

2. Field Blank: µg/ml_____

   Sample #_____

3. Sieve-Wash Blank: µg/ml (in wash water)_____

   Previous Soil Sample #_____

4. Calibration Control Sample: µg/ml:
   Found:_____
   True:_____
   Source:_____ % Recovery:_____

5. Spike Extract Analysis: µg/ml
   Sample Extract Result:_____
   Sample #_____
   Spike Extract Result:_____
   Spike Added:_____
   % Recovery:_____

8.2 CREATION AND IMPLEMENTATION OF THE DATA MANAGEMENT SYSTEM

8.2.1 Introduction

The purpose of the data management system is to collect and store all data generated as part of the Silver Bow Creek Study and to provide basic reports of the monitoring results.

Development of a system to manage and report the sampling data require activity in five general areas:

- Defining data flow and traceability;
- Preparation of data coding forms;
- Creation of a Manual of Codes and Data Coding Procedures;
- Development of handling and reporting software; and
- Generation of computer tapes of raw data, verified data, and validated data for use by such agencies as the Montana Department of Health and Environmental Sciences (MDHES) and the USEPA.

8.2.2 Data Description

- Data Flow

  Figure 8-6 shows the required system of data management. The maintenance of three separate data types (raw, verified, and validated) should be noted.

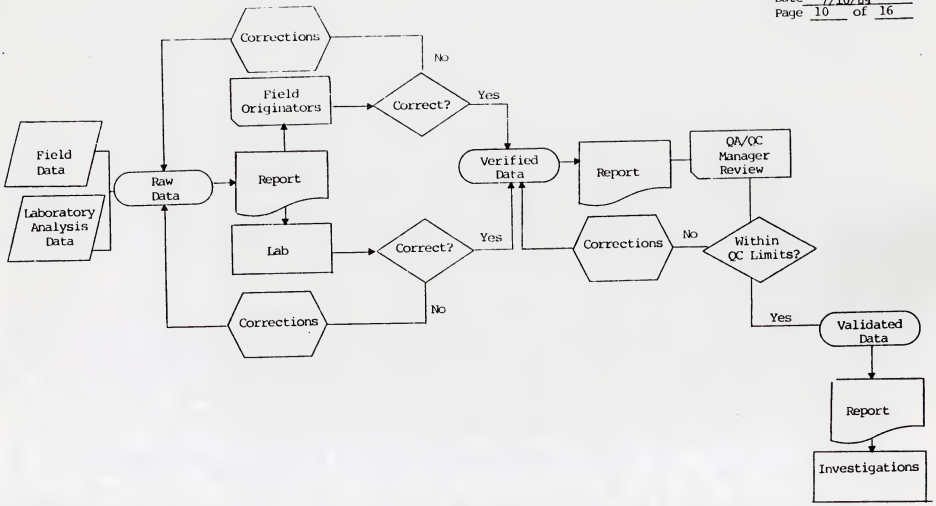


FIGURE 8-6.--DATA FLOW DIAGRAM

The difference among these data types is the level of review involved in ensuring accuracy of the data. The raw data are data which have received a cursory review to confirm that the data have been provided in the proper format. At the raw data level, all key data are correct and all mandatory data supplied.

At the verified data level, the information has all been reviewed by the supplying group (e.g., the analytical laboratories) and any errors in transcription, keying, or processing corrected.

The validated data file corresponds to a much higher level of review. All QC runs, both internal and external, are reviewed in relation to the analytical concentrations and corrections to the data made. This data will be ready for use by the investigators.

8.2.3 Input Data

Input of all data to the system will be done via use of the previously discussed field and laboratory record sheets. The data to be stored in the system have been categorized into two areas:

- Sample data; and
- Analytical data.

In addition, the following special information is required:

- Duplicate (QA/QC) cross-reference data;
- Verification data; and
- Validation data.

These data types are described below.

- Sample Data - Sample data include information such as sample type, location, time, date, and tag numbers. Coding of the field sampling data into the system will occur in the sample bank. The laboratory numbers assigned by the sample bank and other pertinent information will also be entered.

  This sample data recorded on the form, will be keypunched and entered into the data handling system. It will then serve as the basis for generating a tag number/custody number/master ID crossreference system which will be provided to the sample bank on a weekly basis. This form will also serve as a basis for generating delinquency reports for analytical samples which are overdue.

- Analytical Data - A form submitted to the analytical laboratory. These forms will be completed by the laboratory analysts and returned to the sample bank for data entry.

- Duplicate Cross-Reference Data - The sample bank will submit duplicate or triplicate samples to the analytical laboratories as part of the QA/QC program. Each time this is done, an analysis request form giving the duplicate sample ID numbers,

plus any comments as to why the sample was chosen, will be completed by the analytical lab and returned to the sample bank for data entry.

- Verification Procedures - The sample bank will provide a raw data listing to the analytical lab and field data generators, listing sample information together with analysis data. Possible data problems such as missing values, high concentrations, low check sample recoveries, etc., will be highlighted by the sample bank on this computer listing. The labs and field data generators will review the listing and will specify corrective action to be applied to the raw data file. The sample bank will then code forms to accomplish these corrections. It is expected that the principal actions will be ADD, DELETE, or REPLACE and the form will be set up to handle these functions. More complete directions, such as double the value will require special instructions. This form will serve as a record of who made changes, and it will include any notation as to why the changes were necessary. Each sample file will have a place for noting the data has been verified.

- Validation Procedures - Final instructions for creation of validated data are expected to be relatively complex and the form of the instructions, other than a 'delete' function, will most likely have to be applied on a case-by-case basis. Hence, no specific form is envisioned for this purpose. All

validation instructions shall come from the sample bank's QA manager. Each sample file will have a place for noting the data has been validated.

8.3 DATA REPORTING

8.3.1 Output Data Types

A number of reports will be generated from the data files. The reports to be developed are described below.

- ID Number Cross-Reference - Each sample may have from four to eight different tag/custody numbers associated with it. The sample bank sample number will serve as the basis for cataloging all of these numbers. The ID Number Cross-Reference report will provide all necessary cross referencing to determine the master number if some other number (e.g., sample tag number) is known. It will be updated weekly.

- Data Summaries - A listing of all data received during the last processing period (expected to be one-week intervals) will be generated and sent to the appropriate personnel for review. Each file will have a header describing the data file accessed plus other pertinent information. These summaries will be provided as shown in Figure 8-6.

These summaries will be generated in three ways:

- By sample;
- By laboratory and sample; and
- By sample and location (verified data only).

Other summaries can be developed if requested.

- Alert Reports - An alert level for each measurement will be determined. A report of all analytes by sample which exceed this value will be generated. This report will provide a focus for special attention to identify bad data or actual high concentration areas.

- Delinquency Report - A list of all samples for which the sample bank has not been provided analysis data within the prescribed time period will be generated to help track the progress of analysis.

- Intermediate and Final Data Transfer - Validated data files will be transferred to MDHES in MDHES machine readable formats.

8.3.2 Data Management QC Checks

The key components of the data management QC program include the following items:

- Development of uniform data reporting forms;
- Issuance of data reporting/codes manuals to all parties;
- Keypunch verification of all input data;
- Online editing of all input data fields with error reports being issued for review; and
- Log-in of all data report forms received at the sample bank.

These components have been addressed throughout this QA plan.

9.0 QUALITY CONTROL CHECKS

The specific quality control samples for each sample type are listed and described in Section 4.0. Control limits for these comparisons are given in Section 2.0.

This chapter describes how these control checks will be used.

9.1 EVALUATION OF QC DATA

Table 9-1 presents the summarized internal QC measures to be used in the evaluation of water, soil, tailings, vegetation, and tissue data.

9.2 ACCURACY AND PRECISION CALCULATIONS

The representativeness of analysis is a function of precision and accuracy. The formula for calculating accuracy, precision blank ratio and calibration ratio (for Table 9-1) are presented below.

- Precision

  Precision for samples will be estimated from the analysis results of duplicate field samples, split processed samples, split digests or extracts, and analysis replicates. Equation 9-1 will be used to calculate precision (Duplicate Sample Agreement = DSA).

TABLE 9-1.--QUALITY CONTROL CHECKS, ACTIONS LIMITS AND ACTIONS

QC Check	Calculation[1]	Control Limits	Out of Limit Action
Field Duplicates	Precision	Table 2-1	1) Check data for correctness. 2) Check lab replicates for precision. 3) If lab replicates are acceptable, check splits for precision. 4) If splits are acceptable, check sampling methods. 5) If sampling method appears acceptable, reanalyze. 6) If reanalysis gives comparable results, report data as questionable.
Field Blank	Blank Ratio	100-110%	1) Use field blank for blank correction factor for that batch.
SB Reagent Blank	None	None	1) Use for blank correction factor.
SB Spike	Accuracy	Table 2-1	1) Check data for correctness. 2) Check lab spikes for accuracy.
SB Spike (Continued)			3) If lab spikes are acceptable, check NBS accuracy. 4) If NBS accuracy is acceptable, reanalyze sample. 5) If reanalysis gives comparable results, report data as questionable.

TABLE 9-1.--QUALITY CONTROL CHECKS, ACTIONS LIMITS AND ACTIONS (Continued)

QC Check	Calculation[1]	Control Limits	Out of Limit Action
SB Standard	Accuracy	Table 2-1	1) Check data for correctness. 2) Report data as questionable.
SB Spike Duplicate	Accuracy	Table 2-1	1) Check data for correctness. 2) Report data as questionable.
SB Blind Split (of original process material)	Precision	Table 2-1	1) Check data for correctness. 2) Check lab replicates for precision. 3) If lab replicates are acceptable, check field duplicates for precision. 4) If field duplicates are acceptable, reanalyze sample. 5) If reanalysis gives comparable results, report data as questionable.
SB Split Extracts (partials)	Precision	Table 2-1	Same as SB Blind Split
SB Split Digests	Precision	Table 2-1	Same as SB Blind Split
Lab Calibration Standards	Calibration Ratio	90-110%	1) Recalibrate
Lab Spikes	Accuracy	Table 2-1	1) Check correctness. 2) Recalibrate and reanalyze.

TABLE 9-1.--QUALITY CONTROL CHECKS, ACTIONS LIMITS AND ACTIONS (Continued)

QC Check	Calculation[1]	Control Limit	Out of Limit Action
Lab Replicates	Precision	Table 2-1	1) Check correctness. 2) Recalibrate and reanalyze.
Referee Lab Duplicates	Precision	Table 2-1	1) Check data for correctness. 2) Check lab replicates for precision. 3) If lab replicates are acceptable, check extract/digestion splits for precision. 4) If extract/digest splits are acceptable, check blind splits for precision. 5) If blind splits are acceptable, check field duplicates for precision. 6) If field duplicates are acceptable, report data as questionable.

[1] Formulae for the calculation of these values are described in Section 9.2.

$$DSA = \frac{d_1}{(d_1 + d_2)/2} \times 100\% \qquad (9\text{-}1)$$

where: d_1 = First Sample Result

d_2 = Second Sample Result

- Accuracy

Analytical accuracy will be estimated from the laboratory's results on sample bank spikes, standards, sample bank spike duplicates and lab spikes. Equation 9-2 will be used to calculate accuracy.

$$A = \frac{X - T}{T} \times 100\% \qquad (9\text{-}2)$$

where: T = True Value

X = Measured Value

- Blank Ratio

The blank ratio (BR) is defined by equation 9.3.

$$BR = \frac{FB - RB}{FB} \times 100\% \qquad (9\text{-}3)$$

where: FB = Field Blank

RB = Lab Reagent Blank

- Calibration Ratio

The calibration ratio (CR) is defined by equation 9-4.

$$CR = \frac{MC_2 - MC_1}{MC_1} \times 100\% \qquad (9\text{-}4)$$

where: MC_2 = Second mid-range standard value

MC_1 = First mid-range standard value

10.0 PREVENTIVE MAINTENANCE

The required preventive maintenance program for all field and laboratory sampling equipment is presented in Table 10-1. A log book of all maintenance activities will be maintained for each piece of equipment. All equipment will be checked before and after each sampling event, and during long sampling runs when appropriate.

TABLE 10-1.--PREVENTIVE MAINTENANCE SCHEDULE

Instrument	Frequency	Maintenance Check
pH Meters	Daily	Battery check.
	Daily	Check electrode solutions.
	Weekly	Replace batteries.
	Weekly	Check with pH meter tester.
	Continuous	Store electrode in storage solution.
Specific Conductivity Meter	Daily	Battery check.
	Daily	Check cables and switches.
	Weekly	Replace batteries.
	Continuous	Store probes in aqueous solutions.
Dissolved Oxygen Meter	Daily	Battery check.
	Daily	Check cables and switches.
	Weekly	Replace batteries.
	Bi-Weekly	Replace membrane.
	Continuous	Keep membrane moist.
Well Probe	Daily	Battery check.
	Daily	Check graduations.
	Weekly	Replace batteries.
	Weekly	Clean probe with detergent and water.
Flow Meters	Daily	Battery check.
	Daily	Check cables and switches.
	Weekly	Replace batteries.
Continuous Recorders	Monthly	Replace chart.
	Monthly	Replace batteries.
	APMI*	APMI
Continuous Samplers	APMI	APMI
Balance	APMI	APMI
AA Spectrophotometer	APMI	APMI
ICP Spectrophotometer	APMI	APMI
UV Spectrophotometer	APMI	APMI
Leco Sulfer Analyzer	APMI	APMI
Redox/Specific Ion Meters	APMI	APMI
Gas Chromatographs	APMI	APMI
Ion Chromatographs	APMI	APMI

* APMI = As Per Manufacturer's Instructions.

11.0 AUDIT AND CORRECTIVE ACTION PROGRAMS

11.1 SYSTEM AND PERFORMANCE AUDITS

11.1.1 General Information

Throughout the program, audits will be conducted presumably by MDHES and USEPA personnel. In addition, these offices will audit their own information management system(s).

11.1.2 System Audits

11.1.2.1 Sample Collection Audits

The MDHES QA Manager will audit the overall QA system for sample collection, preparation-storage, and transfer just before sampling starts. The intent of this audit is to critically review the entire onsite operation to determine the need for any corrective action early in the program. Throughout the field investigations, designated personnel will also audit the sample collection, identification, and transportation activities to ensure proper QC procedures are being practiced.

A determination will be made by MDHES as to the frequency at which their audits will be performed in the field investigations. This will likely be dependent on such concerns as number of samples

collected, frequency of sample collection, and the "track record" of quality control regarding sampling program implementation.

11.1.2.2 Chain-of-Custody Audits

MDHES personnel will conduct a system audit of the custody system in use on this project. Agency QA personnel will trace specific samples through the system from time-to-time.

11.1.2.3 Analytical Audits

Site visits to contractor analytical labs may be made by MDHES and/or MDHES designated personnel on a periodic basis during active analytical work. Frequent communication between MDHES analytical QA coordinators and each analytical contractor will be maintained throughout the program.

11.1.2.4 Data Management Audits

The MDHES QA Coordinator will audit the data management system by tracing the flow of specific samples through the system. In particular, the ability of the system to correctly identify a sample from any one of its identification numbers will be checked. Copies of the sample bank's logbook pages will be the basis for these performance checks.

11.2 CORRECTIVE ACTION PROCEDURES

11.2.1 Determining the Need for Corrective Action

11.2.1.1 Field Setting

The need for corrective action will be identified as a result of periodic audits described above as well as by other means (e.g., analytical control charts). If problems become apparent, and are identified as originating in the field, immediate corrective action will take place. If immediate corrective action does not resolve the problem, appropriate personnel will be assigned to investigate and determine the cause of the problem. Once a corrective action is implemented, the effectiveness of the action will be verified such that the end result is elimination of the problem.

11.2.1.2 Laboratory Setting

The need for corrective action may be identified by standard QC procedures, control charts, or performance or system audits. Often the experience of a technician or an analyst will be most valuable in alerting him to malfunctioning equipment or suspicious data.

Control limits are stated for each measurement method and are presented in tabular form in Section 2.0.

11.2.2 Immediate Corrective Action

Equipment and instrument malfunctions will require immediate corrective actions. The internal QC tables are working tools which identify appropriate immediate corrective actions to be taken when a control limit has been exceeded; they provide the framework for uniform actions as part of normal operating procedures. The actions taken should be noted in field or laboratory notebooks but no other formal documentation is required, unless further corrective action is necessary. These on-the-spot corrective actions are an everyday part of the QA/QC system; they help avoid the collection of poor quality data.

11.2.3 Long-Term Corrective Action

The need for this action may be identified by standard QC procedures, control charts, or performance or system audits. Any quality problem which cannot be solved by immediate corrective action falls into the long-term category.

The essential steps in a corrective action system are:

- Identify and define the problem;
- Assign responsibility for investigating the problem;
- Investigate and determine the cause of the problem;
- Determine a corrective action to eliminate the problem;

- Assign and accept responsibility for implementing the corrective action;
- Establish effectiveness of the corrective action and implement it; and
- Verify that the corrective action has eliminated the problem.

Documentation of the problem is important to correcting the problem. A Corrective Action Form is filled out by the person finding the problem. This form identifies the problem, possible causes, and the person responsible for action on the problem. The responsible person may be an analyst, field team leader, project QA coordinator, or the QA Manager. If no person is identified as responsible for action, the QA Manager investigates the situation and determines who is responsible in each case.

The Corrective Action Request Form (CA) is shown in Figure 11-1 and includes a description of the corrective action planned, the date it was taken, and space for follow-up. The QA Manager checks to be sure that initial action has been taken and appears effective and, at appropriate later dates, checks again to see if the problem has been fully solved. The QA Manager receives a copy of all CA forms and enters them in a Corrective Action Log. This permanent record documents follow-up and makes any quality problems visible to management; the log may also prove valuable for similar problems and their solutions.

Originator: _____ Date: _____

Person Responsible for Replying: _____ Contract Involved: _____

Description of Problem and When Identified: _____

State Cause of Problem, if Known or Suspected: _____

Sequence of Corrective Action: (If no responsible person is identified, bring this form directly to QA Manager.)

[illegible], Person, and Action Planned:

CA Initially Approved By: _____ Date: _____

Follow-Up Dates _____

Final CA Approval By: _____ Date: _____

Information Copies To:

RESPONSIBLE PERSON: _____

QA MANAGER: _____

DEPARTMENT MANAGER: _____

FIGURE 11-1.--CORRECTIVE ACTION REQUEST FORM

The QA Manager maintains an active follow-up file, filing the CA forms in date order. If the follow-up on the indicated date shows a need for other action or continued follow-up, the action to be taken is identified on the form and it is filed under the date for the next follow-up.

12.0 QUALITY ASSURANCE REPORTING

The field and laboratory supervisors will exercise continuous QA by enforcing all pertinent QC practices, being certain that such requirements are implemented correctly. These continuous QC activities are summarized in Section 12.1, while periodic reports to the MDHES project manager and his QA officer are discussed in Section 12.2.

12.1 CONTINUOUS QA REPORTING

Sections 3.0, 4.0, and 6.0 describe the means by which representative, "unaltered," samples are acquired in the field, then transferred to the laboratory for pertinent laboratory analyses. The essential QA objectives and methods for evaluating their implementation (success) are discussed in Sections 2.0 and 9.0, respectively. Section 7.0 discusses the methods for preparing summaries of raw, verified, and validated data, as well as analytical (error) alert and delinquency reports. The contractors QA manager will be responsible for the preparation of continuous charts reporting all precision and accuracy tests discussed in Section 9.0.

12.2 PERIODIC QA REPORTING

Section 11.0 presents system and performance audits and corrective action programs, which will be implemented periodically by USEPA and/or MDHES personnel. The system audits will evaluate the rigor of sample collection, sample transfer (i.e., chain-of-custody),

analytical and data management plans, as implemented by the particular contractor(s). Sample collection and analytical performance will also be audited by the appropriate regulatory personnel. The various reports will be submitted to the MDHES project manager, and associated QA officer, for their review and comment.

In regards to corrective action procedures (Section 9.2), these efforts will be carried out on an as-needed basis. Copies of all such documents prepared will be sent also to MDHES project management personnel.

The contractors QA manager will submit monthly QC reports to project management summarizing all precision, accuracy, and ratio checks; describing any problems encountered and solutions used; and other pertinent QA data.

13.0 APPENDIX

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